



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :  E21B 17/01, A62C 2/00 F16L 57/00, C09D 5/18		A1	(11) International Publication Number: WO 91/08372  (43) International Publication Date: 13 June 1991 (13.06.91)		
(21) International Application Number: PCT/GB90/01854  (22) International Filing Date: 28 November 1990 (28.11.90)		(74) Agent: FITZPATRICKS; 4 West Regent Street, Glasgow G2 1RS (GB).			
(30) Priority data: 8926967.4 29 November 1989 (29.11.89) GB		(81) Designated States: AT (European patent), AU, BE (European patent), BR, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), NO, SE (European patent), SU, US.			
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(54) Title: FIRE PROTECTED PIPE AND PIPELINE					
(57) Abstract					
<p>An oil carrying pipe for an oil rig riser comprises an anti-corrosion covering (2), a fire protection covering (3) over the anti-corrosion covering (2) and an outer coating (4) to retain the fire protection cover (3) in place. A field joint (5) comprising the three protective coverings (2, 3 and 4), is applied at the base ends of two connected pipes (1). The outer retaining covering (4) comprises a base matrix of a modified ethylene acrylic polymer having a dispersion of metal containing compounds, such as aluminium trihydrate and zinc borate. Under normal conditions the outer coating will protect the pipe against impact, abrasion and the like. Even though the base matrix material will char on exposure to a fire, the metal containing compounds will fuse to form a continuous stable outer coating which will retain the fire protection coating in position long enough to prevent an immediate blow out and thereby allow time to evacuate the larger area.</p>					

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FIRE PROTECTED PIPE AND PIPELINE

This invention relates to fire protected pipelines which carry hazardous materials, particularly inflammable materials, such as risers on off shore installations and crude oil feed pipes at refineries. The invention further relates to a method of forming said pipelines.

Following the tragedy of Piper Alpha, there has been heightened concern about the potential dangers of pipelines carrying inflammable materials. For example the riser, which carries the crude oil from the undersea oil well up to the oil rig, would be exposed to temperatures in the region of 1400°C if there was a fire on the rig platform. At such high temperatures the riser may be damaged allowing the crude oil to ignite and cause a blow out, and thus giving the rig workers have very little warning or chance to escape.

Currently available systems are generally based on concrete which takes twenty eight days to set, is porous and therefore not suitable for risers.

According to a first aspect of the invention there is provided a protected pipe comprising a pipe having anti-corrosion protection, a fire protection covering around the pipe, and a retaining covering around the fire protection covering, said retaining covering being flexible and substantially water impermeable and including a base matrix material having a dispersion of one or more metal containing compounds therein which fuse together upon exposure to a temperature of about 500°C or more to form a stable coating

which in turn retains the fire protection covering in position.

In accordance with a second aspect of the invention there is provided a method of pacifying a pipe against fire comprising forming on the pipe anti-corrosion protection, a fire protection covering around said anti-corrosion protection, and forming a retaining covering around said fire protection covering, said retaining covering being flexible and substantially water impermeable and including a base matrix material having a dispersion of one or more metal containing compounds therein which fuse together upon exposure to a temperature of about 500°C or more to form a stable coating which in turn retains the fire protection covering in position.

When two protected pipes in accordance with the first aspect of the invention are connected, a field joint in accordance with the second aspect of the invention can then be applied to the bare connected ends. In this way an encapsulated protected pipeline of desired length is formed. Such a protected pipeline and the method of forming it constitute further aspects of the invention.

The metal containing compounds should have a sufficiently low melting point, that they will melt on exposure to the heat of a hydrocarbon fire, which may typically be about 800°C to 1400°C, more particularly 1000°C to 1100°C, to form an inorganic type coating which will be stable in the high temperatures of the fire at least about 10 to 15 minutes preferably 1 to 4 hours. In this way even though the base matrix material may char the fused metal

containing coating will hold the outer retaining coating together and thereby retain the fire protection covering on the pipe long enough to prevent an immediate blow out, and thereby allow time to evacuate the danger area.

The inventor has therefore achieved a method of applying and modifying materials in such a way that the combined protection of anti-corrosion and passive fire protection is achieved for steel pipelines. Furthermore for risers and like structures on both off-shore and on-shore installations, the invention can be used both above and below the water line.

When exposed to high temperatures there may be produced from the retaining coating a ceramic-type or glass-type coating which is sufficiently flame resistant to retain the fire protection material in place and thereby delay a blow out of the hydrocarbons in the pipe.

By ceramic-type we mean a crystalline, inorganic metal and by glass-type we mean a non-crystalline solid.

The metal containing compounds can be one or more of metals, metal oxides, borates, hydrates, amines and similar compounds which will melt and fuse and remain stable in a hydrocarbon fire,. The metals of said compounds can be zinc, aluminium, magnanese, magnesium, calcium and iron. To date, the preferred metal containing compounds have been aluminium trihydrate, zinc borate, calcium oxide, zinc oxide, manganese oxide, or a combination thereof. Suitably there should be about 10 to 50% by weight, preferably about 30 to 40% by weight of metal containing compounds dispersed in the outer retaining coating.

The outer retaining coating should in normal operating conditions provide a water impermeable barrier and should be sufficiently flexible to allow both thermal and mechanical movement of the pipe, and protect it again abrasion or impact such as from wave loadings,

Our research to date has shown that a modified elastomeric type material would be desirable as said base matrix material. This could therefore display normal rubber properties, and even though it may char when exposed to high temperatures, the fused metal containing coating would hold it in place thereby retaining the fire protection covering in position on the pipe.

Suitable base matrix material which have been found to date to display the desired properties comprise one or more of an ethylene acrylic polymer, copolymer based on vinyl acetate, polychloroprene, and polyurethane. Preferably a smaller amount of said copolymer is mixed with a major amount of an ethylene acrylic polymer as a viscosity modifier.

Conventional fire protection material is suitable for use in the invention and could be applied in a number of forms. Firstly, for example, several connected slabs of such material could be striated and wound around the pipe. This would allow a thick and flexible covering of fire resistant material to be easily applied to the pipe. For further details reference should be made to our co-pending PCT application no. GB/88/00443 which describes the application of a striated insulation block to a pipe. Alternatively, relatively thin sheets of fire protection

material could be wrapped round the pipe. In this manner thin layers of fire protection material are built up, which could be different grades.

The fire protection material should typically be able to withstand temperatures of about 1400°C for a minimum of about 10 to 15 minutes, preferably one to four hours.

Although anti-corrosion protection of sorts is necessary to prevent excessive pitting and weakening of the pipe, this protection could be realised in a number of ways, such as by a conventional cured polychloroprene (neoprene) based coating, and should not therefore be construed in a limited manner.

The invention will now be described by way of example with reference to the accompanying drawings in which:-

Fig. 1 - is a longitudinal section through a riser pipe having various protective coverings (which includes a field joint), in accordance with the invention;

Fig. 2 - is a plan view of the pipe shown in Fig. 1 but having the protective coverings partially cut away for clarity;

Fig. 3 - is a plan view of a pipe being formed with protective coverings in accordance with the invention; and

Fig. 4 - is a cross-sectional view through the field joint shown in Fig. 1.

A riser carries the crude oil from the well onto the oil rig. In this embodiment, it is to be understood that the well is sub-sea and that the rig is off-shore. If there is a fire on the oil rig the riser above the water line will be liable to damage by the fire and this may lead to a blow

out.

The length of riser pipe illustrated in Figs. 1 and 2 is pacified against fire in accordance with the invention and mitigates this problem. The protected pipes are factory-prepared and then transported to the oil rig where they are welded together and set vertically in place.

Each pipe 1 is coated with an anti-corrosion covering 2, a fire protection covering 3, and retaining covering 4 as follows.

After preparing the pipe by shot blasting, uncured polychloroprene (neoprene) and bonding agents are extruded onto its outer surface apart from about 50 to 70cm at either end 1a of the pipe 1. This extrudate is cured to form the anti-corrosion covering 2.

Next is applied the fire protection covering 3 which comprises a plurality of flat blocks each of which is formed from a conventional fibrous fire protection material such as discussed in the aforementioned PCT application, and has a width of about 30 to 50cm and a depth of about 5cm. One major face of each block (not shown) is deeply grooved (striated) across the width to form a plurality of parallel spaced bars interconnected by webs. The blocks are then joined end to end by webbing to form a continuous strip which, because of the imparted flexibility, of the striations can be spirally wound round the pipe 1, as shown in Fig. 3, to form a continuous relatively thick fire resistant covering 3. As best shown in Figs. 1 and 2 this latter covering stops just short of either end of the anti-corrosion covering 2. For larger diameter pipes, thin

sheets of fire protection material can be applied in a cigarette wrap type fashion.

The whole pipe 1 apart from the exposed ends 1a are then encapsulated (by e.g. extrusion, hand layup or casting) in the outer retaining covering 4 which tapers over the exposed ends of the anti-corrosion 2 and fire protection coverings 3. The retaining covering 4 is formed from a base matrix material of modified elastomer containing inorganic fillers. Other materials are employed to convert the base polymer into a synthetic rubber with a range of desired properties. As with the anti-corrosion covering 2 the retaining covering 4 is also extruded. Both these coverings 2 and 4 are then cured to form the finished pipe. The retaining covering 4 is impermeable to water and due to its elastomeric properties will also lend some abrasion and impact resistance to the system. Furthermore in normal use it will hold the fire protection covering firmly in place.

The outer retaining covering, is prepared as follows (all parts are by weight). 80 parts of Vamac (trade mark of Dupont) which is an ethylene acrylic polymer is mixed with 20 parts of Elvax (trade mark of Dupont) which is a copolymer based on vinyl acetate. To this mixture is then added 1 to 2 parts of an anti-oxidant, 2 to 4 parts of stearic acid, 1 to 2 parts of another lubricant or mixing processing agent, 80 to 130 parts of aluminium trihydrate, 10 to 20 parts of zinc borate, 80 to 130 parts of a mineral filler or re-inforcing agent (such as carbon black), 1 to 2 parts of a vulcanising agent and 2 to 4 parts of cross-linking agent, such as a polysulphate. The metal containing

compounds are well dispersed within the base matrix material. The above polymers (Elvax and Vamac) are non-based polymers with flame resistant elastomers.

In a second example, the outer coating was modified by substituting the aluminium trihydrate and zinc borate with a mixture of calcium oxide, zinc oxide, and manganese oxide at from 10 to 60 parts. These oxides melt/fuse at about 450°C.

The finished protected pipes are connected by welding at their exposed ends 1a and then a field joint 5 applied (see Figs. 1 and 4), again in accordance with the invention. Therefore an anti-corrosion covering 2, fire protection covering 3 and retaining covering 4 will be applied, generally diverging outwardly to conform with the coverings of the two adjacent pipe ends and thereby form a fire protected encapsulated pipeline.

In use, if there is a fire on the oil platform, the high temperatures of the fire will burn away the elastomeric retaining covering 4 and fuse the inorganic fillers to form a brittle ceramic-type fibrous coating which does not disintegrate and retains the fire protection material in place. The riser can therefore be protected against serious damage from the external fire for about one to four hours depending on the type and thickness of the fire protection covering 3. This short period could be critical in the evacuation of the oil rig. The ceramic-type retaining covering will also provide additional mechanical strength and flame protection.

The fire protected pipe of the invention could also be used as crude oil feed pipe to refineries. In fact the

invention would be applicable for any conduit carrying hazardous materials, not necessarily inflammable materials, which may be exposed to an external fire either on shore or off-shore.

It will be appreciated that the fire protection covering is also acting as a heat insulator.

The advantage of the invention over currently available systems are:

- (1) shorter production times;
- (2) capability of serving both above and below water-line;
- (3) capability of being tailored to meet differing requirements; and
- (4) capability of being applied as a field joint.

Claims

1. A protected pipe comprising a pipe having anti-corrosion protection, a fire protection covering around the pipe, and a retaining covering around the fire protection covering, said retaining covering being flexible and substantially water impermeable and including a base matrix material having a dispersion of one or more metal containing compounds therein which fuse together upon exposure to a temperature of about 500°C or more to form a stable coating which in turn retains the fire protection covering in position.
2. A protected pipe as claimed in claim 1 wherein the metal containing compounds are selected from the group consisting of metals, metal oxides, metal borates, metal hydrates and metal amines.
3. A protected pipe as claimed in claim 2 wherein the metals of metal containing compounds are selected from the group consisting of zinc, aluminium, magnesium, manganese, calcium and iron.
4. A protected pipe as claimed in any one of the preceding claims wherein the metal containing compounds are present at from about 10 to 50% by weight.
5. A protected pipe as claimed in any one of the preceding claims wherein the base matrix material includes at least one of the materials selected from the group consisting of an ethylene acrylic polymer, copolymer based on vinyl acetate, polychloroprene, and polyurethane.
6. A method of pacifying a pipe against fire comprising forming on the pipe anti-corrosion protection, a fire protection covering around said anti-corrosion protection, and forming a retaining covering around said

fire protection covering, said retaining covering being flexible and substantially water impermeable and including a base matrix material having a dispersion of one or more metal containing compounds therein which fuse together upon exposure to a temperature of about 500°C or more to form a stable coating which in turn retains the fire protection covering in position.

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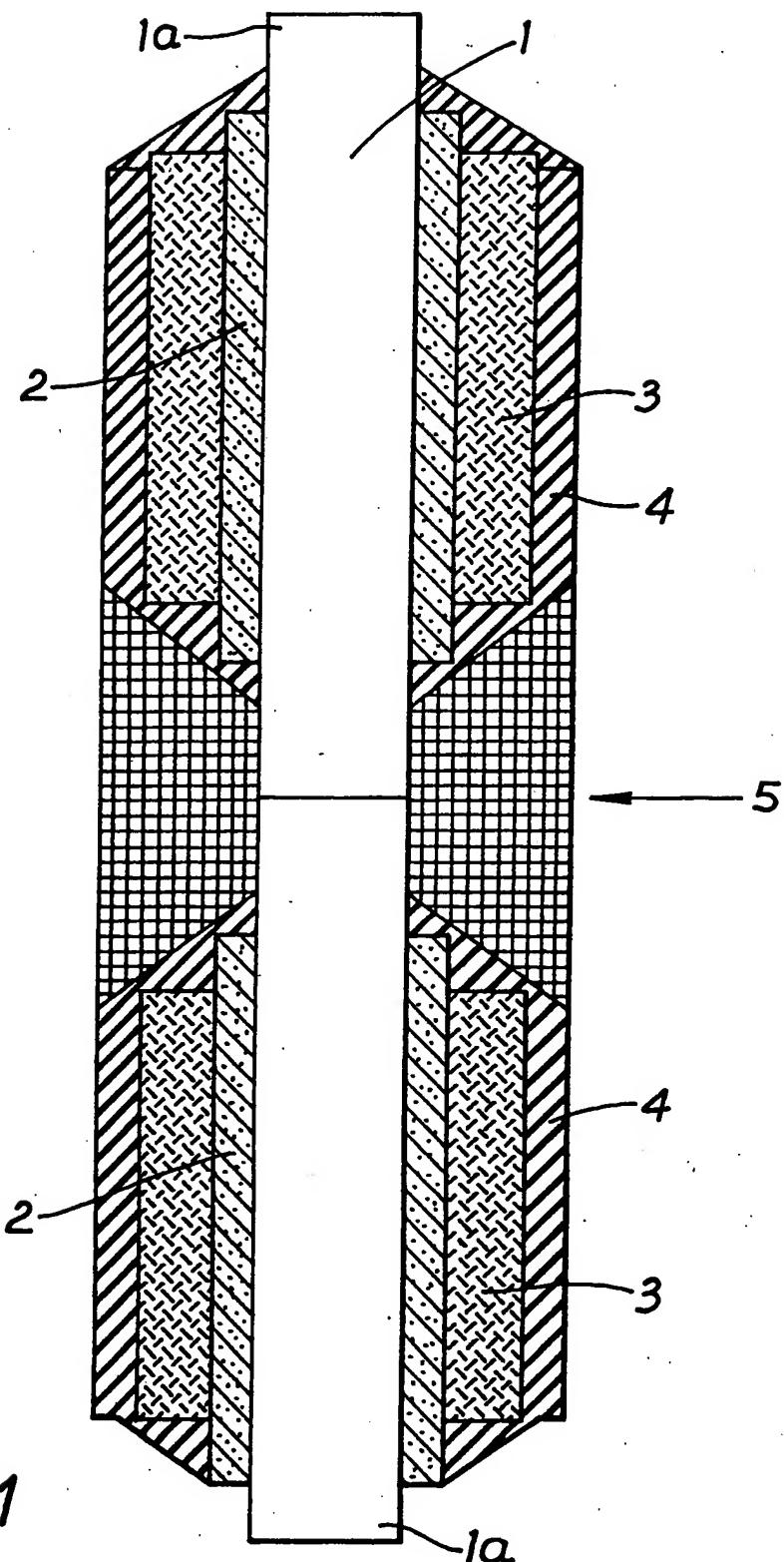


Fig. 1

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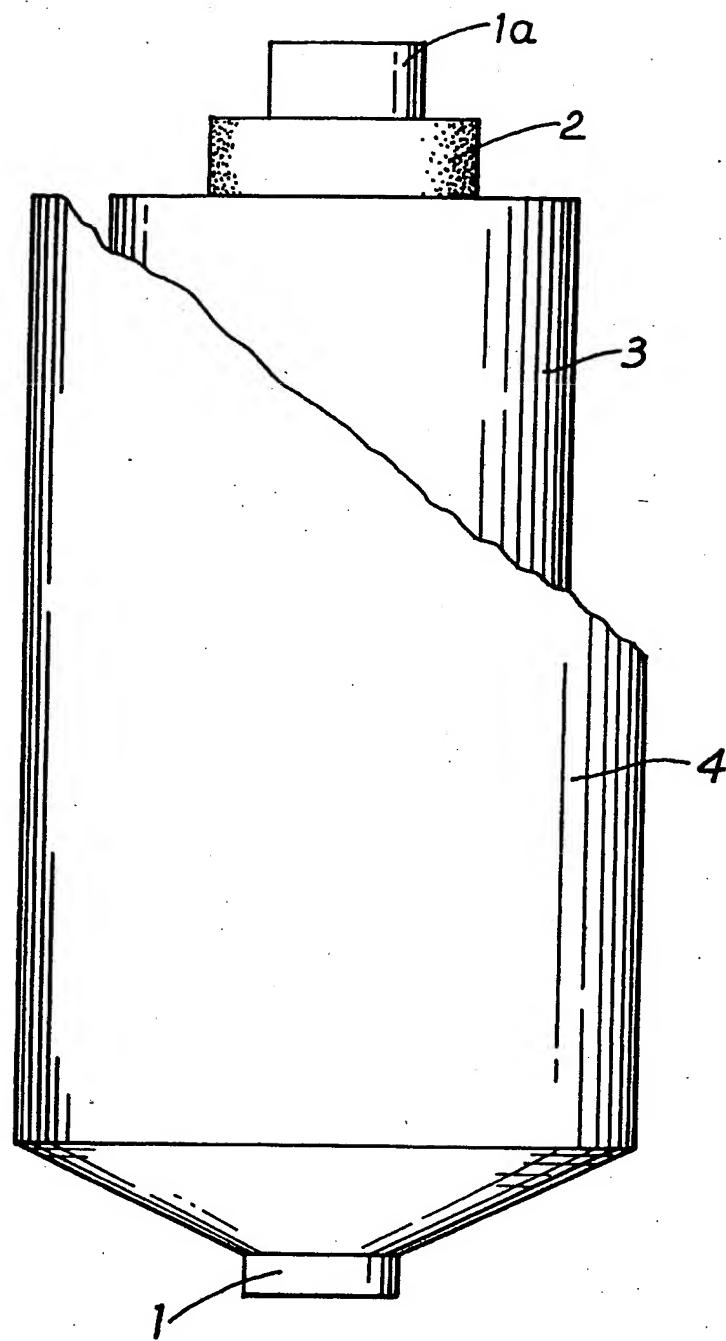


Fig. 2

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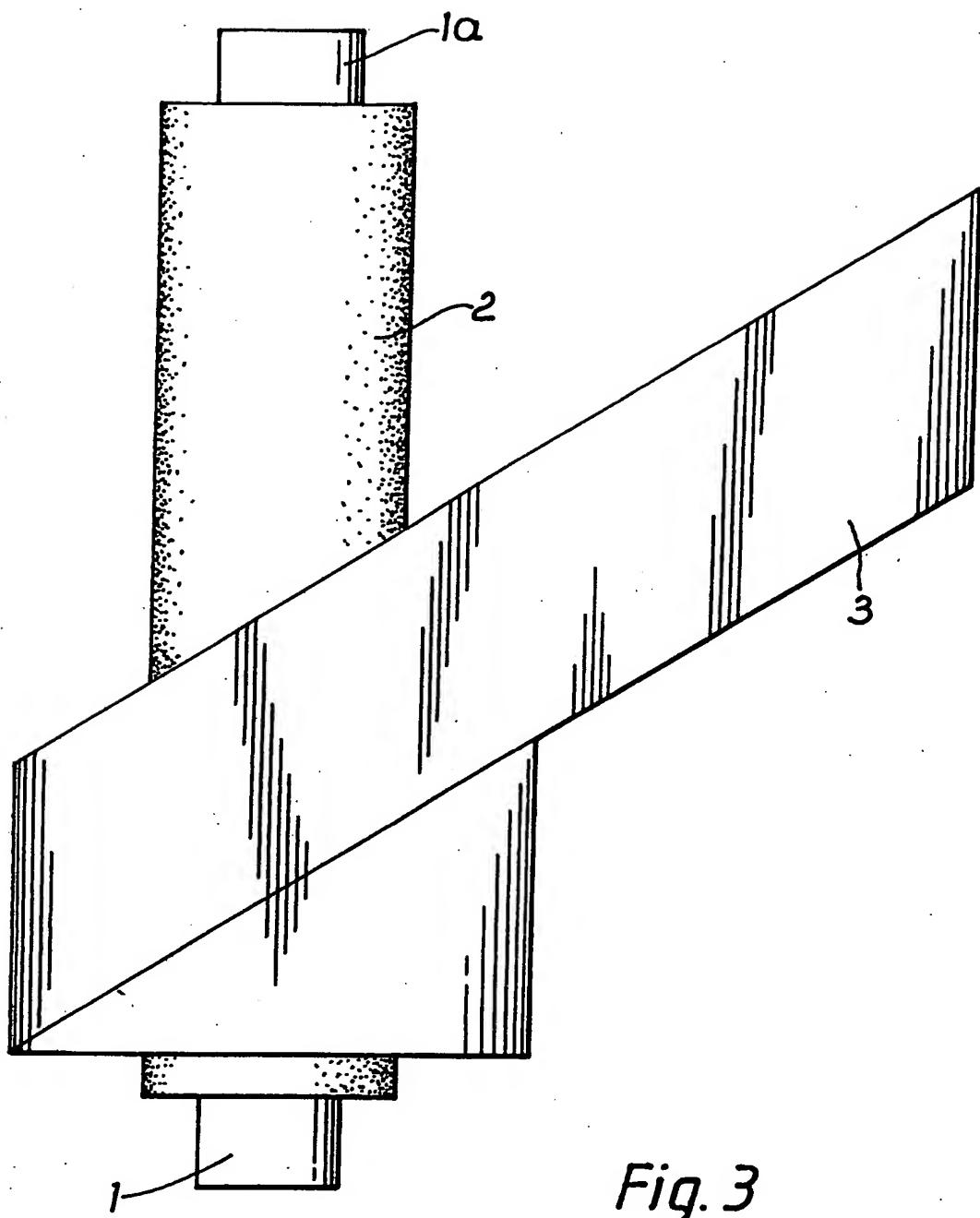


Fig. 3

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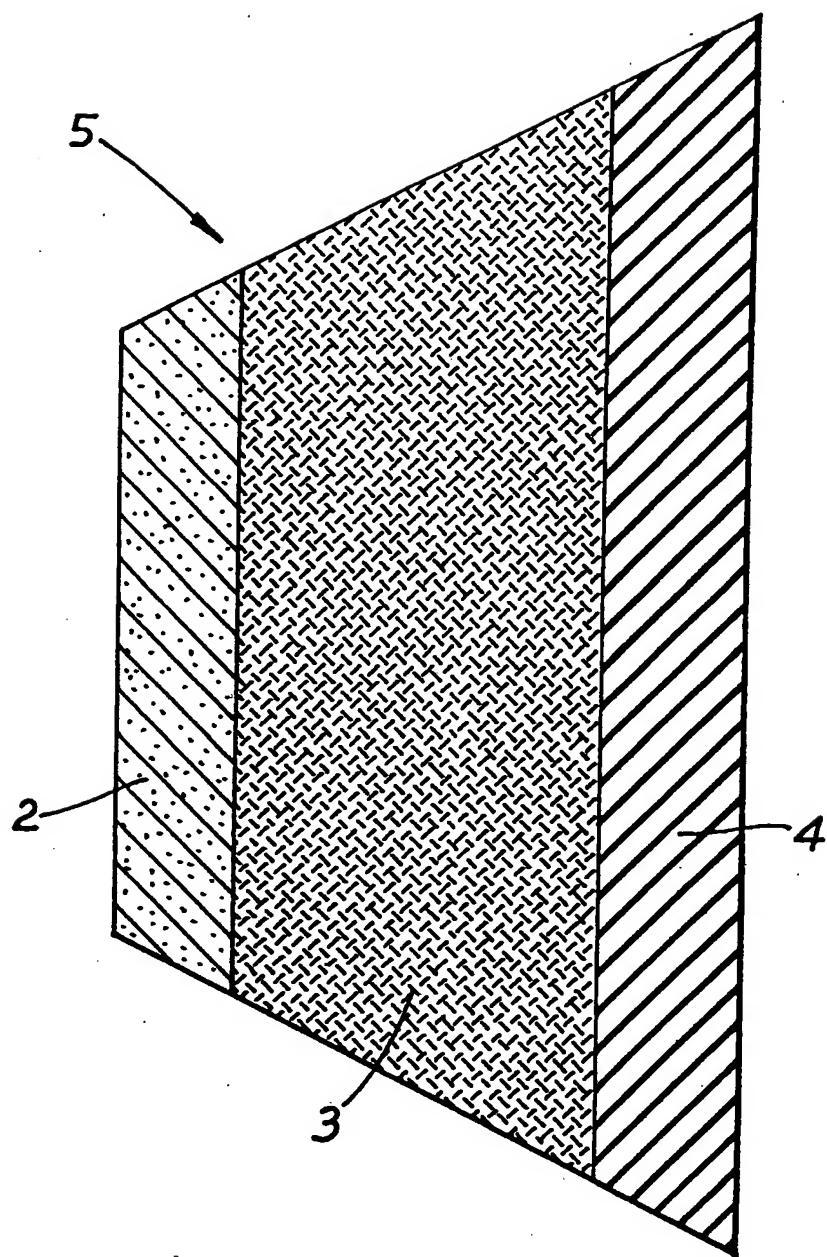


Fig. 4

**SUBSTITUTE SHEET**

# INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 90/01854

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) <sup>6</sup>

According to International Patent Classification (IPC) or to both National Classification and IPC

**IPC<sup>5</sup>: E 21 B 17/01, A 62 C 2/00, F 16 L 57/00, C 09 D 5/18**

## II. FIELDS SEARCHED

Minimum Documentation Searched <sup>7</sup>

Classification System	Classification Symbols
IPC <sup>5</sup>	E 21 B, F 16 L, A 62 C, C 09 D

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>

## III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup>

Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X	WO, A, 88/05885 (EB NORSK KABEL A.S.) 11 August 1988 see page 9, lines 15-30; figure 1	1,6
Y	--	2-5
Y	WO, A, 83/04041 (A.S. NORSK KABELFABRIK) 24 November 1983 see page 2, paragraph 2; page 3, paragraph 2; page 4, paragraph 2; page 8, paragraph 4; figure 1	2-5
A	--	
A	DE, A, 3722359 (CERTIFIED TECHNOLOGIES CORP.) 19 January 1989 see the whole document	1-6
A	--	
A	DE, A, 3730204 (BAYER AG) 30 March 1989 see the whole document	1-6
	--	./. .

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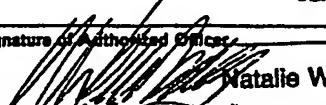
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"A" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search <b>29th January 1991</b>	Date of Mailing of this International Search Report <b>21. 02. 91</b>
International Searching Authority <b>EUROPEAN PATENT OFFICE</b>	Signature of Authorized Officer  <b>Natalie Weinberg</b>

## III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, <sup>13</sup> with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	GB, A, 2138168 (A.S. NORSK KABELFABRIK) 17 October 1984 see page 2, lines 50-55; figure 1  -----	1,6

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

GB 9001854

SA 42285

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 11/02/91. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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